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ABSTRACT

More than 40 studies and reports were reviewed in this paper. Reviewed under Inservice Programs and Activities are: Local Programs, (e.g. Flint Hills Elementary Science Project), Institute Programs (e.g. NSF Summer Institutes) and other inservice activities (e.g. Eastern Regional Institute for Education). The writer reviewed evaluative reports and studies of these programs with reference to (1) teacher content background, (2) changes in teacher attitudes in behaviors, and (3) changes in student achievement. Also reviewed are research studies and reports related to (1) implementation of inservice activities and programs, (2) teaching competencies, curriculum development, and inservice education, and (3) teacher attitudes, behaviors, characteristics. Three general recommendations were made concerning reports and studies of inservice education activities, and fifteen specific recommendations were made concerning (1) the development of local inservice programs, (2) teacher attitudes, behaviors, characteristics, and (3) the adoption, acceptance, and implementation of curriculum projects. (BR)

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SCIENCE EDUCATION INFORMATION
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OCCASIONAL PAPER SERIES - SCIENCE
PAPER 2 - INSERVICE EDUCATION FOR TEACHERS OF ELEMENTARY SCHOOL SCIENCE

by

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Robert W. Howe
and
Stanley L. Helgeson
Editors

INSERVICE EDUCATION ACTIVITIES IN SCIENCE FOR ELEMENTARY TEACHERS

INTRODUCTION

This paper is designed to complement an earlier review of research concerning the preservice education in science of elementary school teachers (9).

Although inservice education is usually considered to encompass any program or set of activities designed to increase the professional competence of teachers, this report has been limited to three broad topics: published descriptions of inservice programs, evaluative reports and studies of inservice activities, and research studies relevant to inservice education for elementary teachers in which the primary concern is that of teaching science. In addition, a final section of this report contains recommendations for the improvement of inservice education activities and programs. The materials reviewed for this paper are limited to those studies, reports, and articles published since 1960.

INSERVICE PROGRAMS AND ACTIVITIES

Local Programs

Much of the work in inservice activities designed to help elementary school teachers improve the science education available in their classrooms centers around programs developed by persons and organizations removed from the local area. Only a few programs developed by local school systems have been described in printed form for public distribution. One is the Flint Hills Elementary Science Project (14).

This program, designed by the Flint Hills School Unified District personnel in cooperation with staff members from Kansas State Teachers College in Emporia, is an attempt to upgrade elementary science and is funded for three years under a grant from the U. S. Office of Education. Physical, life and earth sciences are emphasized. The specific goal is to develop an exemplary instructional program in science for students in grades 6, 7, and 8 in a seven county area of rural Kansas.

Teachers participate in inservice programs and in summer institutes. The focus of the activities is to make the teachers more competent in the use of materials from the Introductory Physical Science program and from the Elementary Science Study program. Teachers also work with life science activities designed by the Educational Research Council of America and with earth science materials. Summer institute programs provide opportunities for intensive inservice work. In 1967, teachers participated in a summer earth science program involving an extensive geological field trip in Kansas and Colorado. In 1968, the emphasis of the summer program was on the life sciences.

Evaluation of the success of the project is in terms of student achievement. Students have been tested, during the first two years of the project, with the Sequential Test of Educational Progress (STEP) and the Test on Understanding Science (TOUS). Two additional testing programs are now being used. One involves the assessment of the Educational Research Council's life science program. The other is a Study of Cognitive Preferences of sixth grade science students.

Available results of evaluation of student performance on the STEP and TOUS tests indicate that the students who received science instruction from teachers participating in the Flint Hills project made significantly greater gains in test scores from pretest to post-test than did students who received similar science instruction from teachers not served by the project.

Another program classified as "local" although it was carried out on a state-wide basis is the New Hampshire inservice program in elementary school art and science (50). This program, supported by Title III funds, was developed in response to a state-wide lack of elementary school art and science specialists. Two teacher education courses, televised throughout the state, provided extension credits from the University of New Hampshire. Anticipated total enrollment was 220 teachers; 920 teachers were actually involved. At least 114 of the state's 188 school districts and 50 percent of the parochial schools had teachers participating in the program.

The statewide program was designed to (1) acquaint teachers with recent innovations in teaching art and science, (2) give teachers confidence in their ability to teach these subjects, (3) provide practical experience with instructional materials, and (4) compel them to teach art and science, using materials, and to evaluate their own progress.

In addition to the televised lessons, instruction was available at regional centers (17 for science and 16 for art) scattered throughout the state. During the two hour sessions at a regional center, the teachers planned a classroom activity to be conducted with their pupils before the next meeting of the regional class. After teaching the lesson, each teacher prepared a written self-evaluation for the regional instructor to examine and discuss.

The first two years of this project are being evaluated. Because one of the goals was to achieve fundamental changes in teacher attitude, objective evaluation is proving difficult. Subjective evaluation, however, has provided much evidence of the success of the courses. Teachers and pupils are enthusiastic. Many teachers consider these courses to be the most practical they have ever taken. Other teachers, administrators and parents have expressed interest in the program.

The personnel of the project believe that "instant" curriculum change (as opposed to that which takes place over a long period of time) has occurred because teachers who formerly refused to teach art and science are actively involved in, and enjoying, these subjects. However, an extensive follow-up research program will be done to determine whether the courses have any truly long range effects on the teaching methods of the teachers enrolled in 1966-67.

The Pacific Science Center (45, 46) at Seattle, Washington, has provided an inservice education program for a number of schools. Introductory as well as in-depth science workshops are conducted for teachers from five school districts as a part of the Puget Sound Arts and Sciences Program. The in-depth workshops, each lasting three weeks, provided teachers from many school districts with opportunities to learn about and use materials from Introductory Physical Science, AAAS-Science: A Process Approach, and Elementary Science Study programs. In addition, there were in-depth workshops in elementary physical science in which the teachers studied units on force and motion, electricity and magnetism. In Concepts in Science, teachers were introduced to an elementary science curriculum incorporating a sequential development of concepts of increasing complexity with increasing grade level. Teachers also learned about nuclear energy in a program entitled "Our Nuclear World."

The Center personnel also provided workshops of an introductory nature in which participating teachers became acquainted with the content and materials of the Earth Science Curriculum Project, the COPES program (Conceptually Oriented Programs in Elementary Science), and the Intermediate Science Curriculum Study. Individuals instrumental in designing and developing these programs came to the Center to serve as instructors for the several one-day sessions.

Another program involving several school systems is the Bi-State Project for the Improvement of In-Service Education Through Science (8). A predominantly rural area, including four counties in Missouri and four in Iowa, is served by the project. Elementary teachers have been provided with assistance in the use of materials from several elementary science programs (SCIS, ESS, AAAS, etc.). Teachers have participated in a four week summer program. Each teacher worked about 50 percent of his time with materials from the specific program he planned to use in his classroom during the coming school year. Consultants visit the classrooms during the academic year on a scheduled basis and are also available at other times if they are needed.

Both teachers and pupils participating in the project are being evaluated. Teacher attitude, both socially and toward the teaching of science, and student achievement are being measured. An article containing data gained from the testing program has been scheduled for publication in late 1969.

Reports of inservice programs developed by a single school or school system are extremely difficult to locate. Only one such report was obtained. The Morgan Hill Unified School District in California (42) conducted a bilingual study, under the ESEA Title I program. The aim was to help children improve their communication skills. Science activities, using Science Curriculum Improvement Study (SCIS) materials, were a part of this program of compensatory language development. Spanish-speaking teacher aides helped the children translate concepts from Spanish into English as they carried out science activities.

Control as well as experimental groups were used in this study. The control groups did not work with the SCIS materials. Evaluation of the study proved difficult. The investigators concluded that a comparison of the two groups produced only the conclusion that the children tended to learn what the teachers emphasized in their teaching.

The report of this study did not contain any detailed explanation of the program for preparing teachers in the experimental group to use the SCIS materials. A workshop was conducted by SCIS staff members. What they did to help the teachers understand and use an inductive approach to science was not specified.

Institute Programs

Reports of Institute programs in science for elementary school teachers are few in number as were reports relating to programs developed by one school system. Although the National Science Foundation began to offer a few Summer Institutes and Inservice Institutes for elementary school teachers and supervisors in 1959, this program has not expanded as has the program serving secondary school science and mathematics teachers. Early NSF programs for elementary school teachers were designed to provide orientation toward the theory of arithmetic and to introduce the unifying ideas of the physical, biological and earth sciences. Emphasis was placed on the selection of "key" teachers and supervisors who might be able to spread the influence of the programs to several classrooms.

Information gained from four years of operating programs for "key" teachers and supervisors indicates an increase in the substantive knowledge of over 5,000 individuals. These people have, in turn, influenced the science education programs of their schools or school systems, either through direct teaching by these teachers as "specialists" in science or mathematics or through curricular changes and inservice activities.

However, there were approximately 1,050,000 teachers of grades K-6 employed in 1962-63. This number is growing by approximately 30,000 teachers each year. It would be impossible to involve a majority of these individuals in NSF institute programs. If money were available, colleges and universities probably would not have sufficient staff members to conduct the programs. The approach has been that of a "pilot program" rather than one which attempts to reach the majority of elementary school teachers. This limited pilot program has served as a testing ground for experimental courses for the training of elementary teachers in the natural sciences. In addition, the task of improving the teaching of arithmetic has been begun via a better understanding of the structure of the number system (43).

Other Inservice Activities, Programs

In addition to local, statewide, and area inservice programs, inservice activities in elementary school science are being developed by organizations and by curriculum development projects. The program of the Eastern Regional Institute for Education (ERIE) involves the use of materials from Science: A Process Approach (25).

There are four main objectives of the ERIE program: (1) to design a system for installing and monitoring a new curriculum in schools of varied characteristics, (2) to test and improve this system, (3) to assess the impact of the curriculum installation accomplished, and (4) to develop and formulate procedures and materials that will promote the widespread adoption of the new curriculum through the replication of the tested ERIE model.

ERIE staff members are interested in promoting such processes as paying attention, remembering, rule-following, and divergent thinking. In addition to the cognitive domain, they are also interested in the affective domain of feelings, motives, and values. As a result they are attempting to identify curricular units which promote these processes and to build these into a comprehensive elementary school program.

The task of defining, designing, testing and installing process-promoting curricula, begun in 1966, is continuing and expanding, involving more teachers in inservice activities. Teachers in a two-state area (New York and Pennsylvania) have been involved in intensive training in summer workshops, augmented by a continuing academic year science consultant program serving 21 pilot schools and 31 demonstration schools.

The emphasis in science education for elementary school children is also being changed through a program entitled "Child-Structured Learning in Science" (CSLS) (40). This program developed by science educators at Florida State University is based on the assumption that if objects in a child's environment are carefully selected and sequenced, the child can assume responsibility for deciding which activities are appropriate and meaningful to him.

The influence of the work of Jean Piaget is evident in this program. The CSLS assumption that the young child should have frequent science experiences in which he is free to "make up" some scientific knowledge for himself requires inservice activities for teachers that enable the teachers to understand and make the most effective use of this philosophy.

The teacher preparation program consists of two parts: (1) a one week workshop and (2) an inservice program of biweekly meetings of teachers. Videotaped classroom sessions and individual interviews with children are available for use in the workshop. In addition, 15 30-minute television programs are available for use in the inservice program. During the workshop, the teachers perform representative activities from the CSLS program and become acquainted with the work of Piaget. They also work with children. One such workshop, for persons who will serve as coordinators for trial use of the CSLS program during the coming academic year, was held during the summer of 1969.

Programs for individuals who are, or will be, working with the Science Curriculum Improvement Study (SCIS) materials, were also held during the summer of 1969 (39). One representative program was that held at Michigan State University. During this four week workshop, participants were prepared to serve as resource people available to consult with school systems on problems of curriculum implementation.

The Michigan program has six main objectives: (1) to provide the participants with knowledge of the purpose, history, recommended mode of teaching, objectives, materials, and teacher education procedures of SCIS; (2) to provide opportunities to teach children science using SCIS materials and to provide feedback on the teaching; (3) to engage the participants in giving feedback to elementary school teachers who have been observed while using SCIS materials; (4) to familiarize the participants with the school setting and with the administrative aspects of implementation; (5) to assist the participants as a group and as individuals to plan and to prepare appropriate materials and activities for orientation sessions and inservice programs; (6) to provide experience in organizing and presenting orientation sessions on the SCIS program to groups of school teachers and administrators.

The Education Development Center in Massachusetts also conducts inservice activities for teachers who are using, or are interested in using, the units and materials of the Elementary Science Study (ESS) program. Inservice education is accomplished through in-house workshops, regional implementation centers, and workshops especially conducted for groups visiting the Education Development Center (52).

In-house workshops of one week duration are held six times during the school year and are open to teachers, administrators, and others. A program was begun in 1968 to develop 24 regional centers at which two week workshops for teachers could be conducted. Teams conducting the workshops receive training at Newton, Massachusetts, prior to the regional programs. These teams are also available to work with teachers during the school year. The ESS staff will, on request, travel to school systems to conduct introductory workshops.

Another elementary school science program which has been in use for several years is Science: A Process Approach, sponsored by the American Association for the Advancement of Science. Individuals who have been actively involved with this program were contacted for reports of the inservice activities and any evaluation of their success. The information available was of the type found in articles written by people who had used the AAAS materials and in reports in the Newsletter published by the AAAS Commission on Science Education.

A commercially-developed elementary school inservice education program called "Starting Tomorrow" has been produced by the Ealing Corporation (27). The objective of this program is to assist local school districts in building more productive inservice programs by involving the teachers in working with materials and teaching techniques which have been tested with elementary school pupils.

The program consists of six multi-media packages designed to involve teachers in a "discovery" approach. Only one of these packages concerns science. Each package contains two workshop films, a workshop leader's guide, participating teachers' guides, and classroom materials. Such a kit can serve as the basis for two or more 60 to 90 minute workshops. The science package involves a study of air pressure and of simple electrical circuits.

Other inservice activities and programs have been described in materials classified as research and/or evaluative reports and studies and will be discussed in subsequent sections of this paper.

EVALUATIVE REPORTS, STUDIES

Many of the inservice programs in science for elementary school teachers appear to lack a formal evaluation component. In others, the evaluation activities are still in progress. The evaluation of inservice activities for elementary school teachers does not appear to be a popular area of study for doctoral candidates, a fact which does not apply to secondary school science inservice programs of various types. The lack of interest by doctoral candidates may be related to the fact that there are fewer NSF institute programs.

The evaluative studies and reports described in this section of the paper have been grouped according to whether the success of the program was determined by the criteria of (1) increase in teacher content background, (2) changes in teacher behaviors and/or attitudes, and (3) changes in student achievement. A fourth group consists of reports of evaluative activities still in progress as well as those of the more informal feedback type of evaluation.

Teacher Content Background Studies

Fowler (31) evaluated an institute for the training of elementary school science resource teachers. The 45 participants were pre- and post-tested, using different forms of the Read General Science Test. Fowler found a significant gain in achievement in general science as a result of participation in this program.

The goal of providing a good working knowledge of general science was only one of seven set up for the program. The other objectives of the institute were to help participants develop (2) leadership in science curriculum planning; (3) ability to conduct inservice training programs in science for their school building or system; (4) skills to use in aiding individual teachers; (5) ability to identify school needs for equipment and reference materials and to provide leadership in obtaining, organizing, and maintaining these materials; (6) contact with professional organizations concerned with the improvement of science education at the elementary school level, and to maintain this contact; and (7) instructional materials, with the help of colleagues, which can be used to teach science. Apparently these six objectives were not assessed in the evaluation of the effectiveness of this particular institute program.

Changes in Teacher Attitudes, Behaviors

Caldwell (22) evaluated an inservice science methods course by systematic observation of classroom activities. He set three goals for his study: (1) to develop an instrument which measures the ratio of time a teacher spends teaching with indirect activities (those in which he acts as co-ordinator of learning experiences) to the time he spends teaching with direct activities (those in which he imparts knowledge); (2) to devise an inservice science methods course which encourages fifth grade teachers to use indirect activities when teaching science; (3) to measure effects of the methods course on teaching techniques of participating teachers.

The instrument, "Activity Categories," contains six classifications of indirect activities (e.g. laboratory experiences, both open-ended and structured; student demonstrations), three categories labeled "direct activities" (teacher demonstration, lecture, workbook work), and two activities not categorized as being either direct or indirect; teacher questioning and "general havoc." Caldwell felt that, in these two activities, students are not participating in learning experiences nor is the teacher imparting knowledge.

The 30 fifth grade teachers participating in the study were randomly assigned to experimental and control groups. Those in the experimental group were enrolled in a methods course in which they discussed a rationale for using indirect activities, observed demonstration lessons using laboratory experiences, and prepared and taught, to two classes, two lessons based on laboratory experiences.

Each of the teachers participating in the study was observed in the classroom. Independent observations were made by at least two of the three observers conducting the study. All teachers were observed 10 times while teaching science: four times before the experimental group participated in the methods course, twice while the methods course was being given, and four times after the course ended. Activity ratios, laboratory ratios, and questioning ratios were calculated, using data obtained before and after the methods course.

Caldwell found a distinct and measurable change in the teaching techniques of the teachers in the experimental group. There was no significant change in teaching techniques of the teachers in the control group. After the inservice course, the teachers in the experimental group used indirect activities and laboratory activities to a greater extent than prior to the methods course. Many of the laboratory experiences observed in the classrooms were different from those prepared for the methods course, either by the instructor or by the participating teachers. Apparently these teachers had applied the skills developed in the course to other topics they taught.

Two limiting factors were noted. Teachers knew in advance when they would be observed and thus had an opportunity to prepare special lessons. Teachers in the experimental group were observed teaching physical science topics more frequently after the methods course than before it began. Caldwell had no way of determining if physical science was an area of study in which the teachers normally used more laboratory experiences.

The New Hampshire program (50) involving inservice education in art and science for elementary teachers had four operational goals to help teachers (1) develop a set of contemporary goals for their elementary school science programs, (2) redefine their role in the learning process in terms of the new goals they had established, (3) develop a series of science activities which could be used in guiding children toward the contemporary goals of elementary science education, and (4) conduct science activities in a manner consistent with their new concept of the teacher's role in the learning process.

Questionnaires and classroom visits were used to obtain information relative to the achievement of these goals. Questionnaires were mailed to teachers enrolled in the science inservice course. Using a roster of the teacher participants, names were randomly selected. The evaluation of the success of the science part of the inservice program was based on information from 81 completed questionnaires and from 14 classroom visits and interviews.

All four operational goals were not achieved. In the few instances where science was an integral part of the elementary curriculum, the teachers measured the success of their program in terms of the quantity of factual scientific information their students were able to absorb in a given period of time. Teachers considered their role in the learning process to be that of selecting, translating and transmitting scientific information. No change in role concept was evident when the classroom visits were made.

Evidence from the questionnaires indicated that (1) there had been a significant decrease in the number of teachers using the textbook as the main source of ideas for science activities, (2) the frequency with which the textbook was used as the primary science experience (reading, writing, recitation) had decreased, (3) there was a significant increase in the number of teachers offering their pupils a wider variety of science experiences, allowing the children to develop many of the skills of scientific inquiry, (4) the number of teachers encouraging their pupils to become actively involved in planning science activities increased significantly, and (5) fewer than half of the teachers who felt that a lack of science knowledge was a major obstacle to teaching science retained this feeling after completing the inservice course.

When the classroom visits were made, an obvious discrepancy was found to exist between the information obtained from the questionnaires and the reality of the classroom. Many of the teachers interviewed indicated that serious obstacles still stood between them and an effective science program: (1) lack of time to prepare science lessons, (2) lack of time in the daily schedule to teach science, (3) lack of storage and work space, (4) lack of confidence in their ability to evaluate pupil progress, and (5) lack of science subject-matter knowledge.

The principal authors of the evaluation report list three reasons which may explain the discrepancy between questionnaire replies and classroom behavior. First, perhaps only those teachers who had a "good" experience with the course responded to the questionnaires, resulting in a sample which did not represent a true cross-section of the people involved. Second, the teachers were asked to draw subjective conclusions about their own instructional practices. Such conclusions might not be consistent with those of an impartial and objective observer. Third, although the questionnaires might reveal the kinds and numbers of changes which took place in teaching practices, these instruments were not designed to indicate the degree or quality of these changes. For instance, more students might be involved in direct experiences with science materials, but the experiences might not necessarily be effective in producing learning.

During the inservice science course teachers were required to develop science activities which could be used in their classrooms. In only two of the 14 visits could observers find any indication that these activities were being used by children to meet any of the contemporary goals of elementary science education. In only three instances were these activities being conducted on a regular basis.

The inservice course was designed to cause teachers to make changes in their traditional classroom patterns. The classroom observations provided no evidence that a significant number of teachers who took the course were now conducting science activities in a manner that would guide their pupils toward any of the current goals of elementary science education.

The course appeared to have been most effective in improving the quality of elementary science education in those classrooms where the teachers worked in a school system in which science was an integral part of the curriculum at their particular grade level. New Hampshire does not require that science be taught in the primary grades. None of the primary grade teachers visited was required by the local school system to teach science, and the fact that they had participated in the inservice program did not appear to have increased the number teaching science in the primary grades.

The investigators felt that the principal reason for the relatively limited success of the inservice course in meeting its primary goal could be traced directly to the teaching environment of the typical participant. It is their opinion that "until educational priorities are established which can afford the experiences that science can provide a prominent position in the elementary curriculum, . . . this subject will continue to be ineffectively taught, regardless of the good intentions and best efforts of the classroom teacher."

Brittain and Sparks (15) also investigated the effectiveness of an inservice course in science for elementary school teachers. At the beginning and end of the inservice course, teachers were given a checklist of problems regarded as serious. The investigators examined items on the checklist for which difficulty had shifted from lesser to greater by 15 or more ranks. They found the predominant trend was in the direction of reporting instructional problems as less serious upon completion of the inservice course. However, problems such as evaluating science learnings, obtaining information on where to get help in teaching science to children, locating sources for free and inexpensive materials, making science continuous through the elementary grades, etc. were ranked as more difficult at the end than at the beginning of the course.

Brittain and Sparks also found the tendency to report some problems as being more serious at the end of the inservice course was more pronounced for the upper-grade teachers for whom the structure and content of the inservice course were thought more suitable than for the primary grade teachers. They concluded that teachers benefitting most from the course rated difficulties relating to obtaining materials, inadequate facilities, etc. higher at the end of the course. Brittain and Sparks inferred that this situation resulted from the fact that these teachers were emphasizing science in their classrooms and using a variety of materials and were therefore more cognizant of factors limiting their science teaching.

Changes in Student Achievement

Evaluation activities have been a part of the Flint Hills program described earlier in this paper (14). Both teachers and students have been evaluated. The teachers participating in the program were tested, in a pre-and post-test design, using the Science Process Measure for Teachers. After six weeks of work in the summer program, the average score increase was 13.4 points (66.7 to 80.1, of 100 possible points).

Twenty-six of the 47 teachers enrolled in the summer program taught Science: A Process Approach during the academic year. The other 21 developed their own science program emphasizing laboratory experiences. Evaluation of the success of the subsequent academic year program was based, in part, on a pre-and post-test design using student achievement in science as a criterion. Students in kindergarten through grade three were involved. No attempt was made to measure the effectiveness of individual teachers.

A randomly selected group of students at each grade level was sampled to determine any gain in achievement. In September, 15 students from the control group and 20 from the experimental group (randomly selected at each grade level, K-3) were pretested, using sets of competency tasks compiled by staff members working on the study. Both the experimental and control groups were retested in May to determine any gain in achievement.

The investigators found that, at all four grade levels involved in the study, there were no initial significant differences between the control and experimental groups as measured by the pretest sets of competency tasks. Both groups were post-tested with the same instruments. In all four grades, significant achievement differences existed in favor of the experimental group. The results of this study indicate that the students involved in the AAAS program consistently achieved more of the stated objectives than did the students in the control group. No inferences were drawn relative to the cause of this result.

Hunt (34) assessed the effectiveness of a space science television series as an instrument of inservice education combined with instructional materials prepared by the San Diego Community Educational Resources Project. His criterion was changed pupil behavior as reflected by an achievement assessment using a 50 item standardized science test.

Fifth and sixth grade teachers and pupils participating in summer school in two districts were randomly selected for the study. Teachers were matched according to experience and professional training. The six teachers comprising the experimental group participated in seven hours of inservice training which consisted of viewing and discussing kinescopes related to the space science program. They also used instructional materials prepared for this course of study.

The children in the experimental and control groups were pre- and post-tested, using the 50 item standardized science achievement test. The two groups were found to be comparable in ability and achievement, with the exception of the students in the fifth grade experimental group who scored higher than those in the fifth grade control group on the pretest. Differences between pretest and post-test scores were computed as well as the mean net gains for the treatment groups, in order to rule out the effects of initial position of the treatment groups.

After analyzing the data, Hunt concluded that students whose teachers received the inservice training and used the special materials had made significantly greater gains in space science achievement. He also concluded that the simultaneous use of an inservice education program combined with instructional materials was an effective method for communicating new knowledge to the student via the teacher.

McBride (38) also investigated the effectiveness of an inservice program in science by comparing achievement of children whose teachers had enrolled in an inservice course with those whose teachers had not received this training. The inservice training program used was that instituted at Cornell University in 1961 to train people who would then return to their home school districts to teach physical science concepts to selected elementary school teachers.

Test items and administrative procedures were developed through a pilot study involving 387 fifth and sixth grade students. A state-wide pretest was used to revise test items and to determine if the experimental and control groups were equal in science background at the beginning of the school year. A state-wide post-test was administered at the conclusion of the program to determine if there was a significant gain in science achievement by pupils whose teachers had taken the inservice science course.

McBride found that, at the fifth grade level, there was no significant difference in the achievement of the two groups of children. At the sixth grade level the children whose teachers had the inservice program did slightly, but significantly, better on the science test than did those children whose teachers had not participated in the inservice program. He attributed the limited gain in achievement to several factors: (1) use of a strictly factual recall test, (2) lack of time during the testing period for teachers to present new material to their classes, (3) variations in the teachers' science backgrounds, (4) degree of acceptance of the program by administrative personnel.

Brandt (12) developed and evaluated an inservice education program for first grade teachers teaching an experimental program in social studies and science. This program was developed for use with disadvantaged Mexican-American children.

The success of this program designed to promote concept and language development was measured in terms of student achievement. In addition to the data obtained from the Metropolitan Readiness Test (Forms R and A), and the Metropolitan Achievement Test Battery (Primary I, Form A), classroom observations, evaluative questionnaires and attitude inventories were used.

Three control groups were involved in the study. The experimental group, Group A, involved a special program for students plus inservice training for teachers. In Group B, children were taught the regular program of social studies and science in a team teaching situation in which the teachers were given no special inservice program. In Group C, the children were given the regular social studies and science program in self-contained classrooms and were taught by teachers with no special inservice program. In Group D, children were taught the special social studies and science program by teachers with no special inservice training.

Brandt found her evidence did not support the idea that this experimental program was effective in changing behavior during one year. The standardized tests used in her study were not appropriate for measuring the readiness and achievement of the children in her population. Language deficiency, lack of experience, and differences in cultural background contributed to low levels of performance on these tests. The two main features of the children's program (concept and language development) were not measured by the tests used. In addition, certain variables (e.g. teacher personality, attitude, and style of teaching) could not be controlled.

A different instrument of evaluation might have more accurately measured the outcomes of the children's program. The effects of the inservice program might not have been ready for evaluation at the time when this was done. It is also possible that the inservice program might not have produced changes in teacher behavior, even if assessed at a later time.

An additional problem which Brandt included in her study was the identification of opportunities for children to develop different modes of thinking provided by teachers who had participated in the special inservice program provided. An instrument, developed by Biles, was used to classify cognitive processes involving modes of thinking. Analysis of classroom interaction in science and social studies classes showed that about 90 per cent of the questions teachers asked were classified in the two lowest categories of Bile's instrument (information input and memory; deriving meaning). Teachers appear to need assistance in providing for all levels of cognitive processes and skills.

When Brandt analyzed teachers' responses to the attitude inventory and the evaluative questionnaire, she found much variation among the groups of teachers. More differences in attitude were noted within the groups than among them. This was particularly noticeable within the experimental group as well as within Group C. Nevertheless, Brandt concluded that there were no great differences in attitudes of teachers of the various groups.

Other Evaluative Reports

Personal communication from staff personnel involved in the Elementary Science Study provided some information relative to evaluation activities (52). This portion of the inservice program of ESS appears to consist primarily of informal feedback, both oral and written. A more formal investigation is planned, however. The ESS personnel are interested in knowing what has happened to persons who have participated in the in-house workshops held during the last four and one-half years. The 800-plus participants will be sent questionnaires, and certain individuals will be selected for observation in their classrooms. The general objectives of this investigation are to find out what these people are doing or not doing as a result of their ESS in-house workshop experience and to determine what has or has not happened in their schools as a result of their efforts.

The staff of the Eastern Regional Institute for Education (ERIE) has not yet issued any formal evaluative reports regarding the inservice component of their process-oriented approach to science education in the elementary school. The program has expanded to include 21 pilot schools, 31 demonstration schools, and a network of 45 university-based professors of science and science education (25). All of this activity is still considered as an extension of field study. Public and parochial, rich and poor, large and small, rural and urban are terms used by the ERIE staff to describe the types of schools involved in the project. Such a diversity should produce interesting information when evaluative reports do become available for public information.

As a part of the evaluation component of its program, the American Association for the Advancement of Science, through the Commission on Science Education, has issued a report entitled "An Evaluation Model and Its Application." This report (2), published in 1968, contains information about evaluation results from the second and third years of the project (1964-65, 1965-66). The primary emphasis is upon the evaluation of the new program and its implementation in the public schools rather than upon inservice activities for teachers. This monograph will be discussed in more detail in the "recommendations" portion of this paper.

RESEARCH STUDIES, REPORTS

Some of the studies and reports cited in this section include an evaluative component. The primary emphasis in these studies was a topic other than evaluation, however. The studies and reports cited have been placed in four large categories: (1) studies concerning methods of implementing inservice programs, (2) studies focusing on teacher competencies, (3) studies combining curriculum development with inservice education, and (4) studies emphasizing changes in teacher attitudes and behaviors.

Implementation of Inservice Activities, Programs

Bunsen (16) compared methods of inservice education in science for elementary teachers. All teachers involved in this study used Science: A Process Approach. The 16 elementary teachers participating in the study were categorized as (1) "lead teachers," who had worked with the AAAS materials and had taught a science inservice class to other elementary teachers; (2) "inservice teachers," who had participated as students in this inservice program; (3) "methods teachers," who had received their training in an elementary science methods course in some college or university; and (4) "unexposed teachers," who had no formal exposure to the AAAS materials prior to using them in the classroom.

The effectiveness of these various approaches to teacher preparation was measured in terms of the achievement of the 128 children involved. Pupils in grades one, two, three, and five were pre- and post-tested, using the AAAS process instrument. Odd-numbered tasks relating to the processes of classification, space/time relations, and communication were used for the pretest; even-numbered tasks, for the post-test. The students' general ability was measured with the Otis Quick Scoring Test of Mental Ability, Alpha and Beta, Form A. Only three months time was involved between the pre- and post-test measures. This relatively short time span may have imposed some limitations on the results of the study.

Analyzing his data for sources of within group variation, Bunsen found no significant differences in pupil achievement within the four teacher categories on the processes of classification and space/time relations. There was a significant difference within the four teacher categories on the process of communication. When pupils of "lead teachers" were compared with those in each of the other three categories, all of the significant differences favored the "lead teachers." "Inservice" and "methods" teachers also fared significantly better than "unexposed" teachers in terms of student performance. There was, however, no significant difference in comparison between pupils of "inservice" and "methods" teachers. Bunsen also found that the students of teachers with some form of prior preparation scored higher in all cases than the students of teachers with no preparation.

Bunsen concluded that using AAAS materials in a teaching situation prior to implementing the program in the classroom is favorably associated with higher student score means in the process of communication. This may result from the fact that this process, in the AAAS program, focuses on developing student competencies in graphing and graph interpretation. Student achievement in this area may be more highly dependent upon prior teacher preparation than is achievement in the processes of classification and space/time relations.

Westmeyer and some colleagues also worked with different methods of inservice education and the adoption of the AAAS program (54). This project involved 120 teachers and 3,600 students. Three different approaches to teacher education were investigated: (1) summer institute training, (2) an inservice course, and (3) the use of a specially-designed teacher manual which substituted for more formal training in the use of the AAAS materials. (A fourth group, in which the AAAS materials were not used with children, served as a control group.)

Information obtained from classroom observations carried out by a trained team of observers, from an attitude questionnaire regarding the project and its effectiveness, and from scores on objective tests administered to selected children was used to assess the effectiveness of each method of teacher education.

After one year of instruction in Science: A Process Approach, there were no significant differences among the average process capabilities of each of the three experimental groups of children at specified grade levels (1, 2, and 3) as measured by the objective process capability instrument. In addition, these three groups did not differ significantly from the untreated control group in respect to process capability as measured by the instrument. The investigators inferred, on the basis of the good performance of the children in the control group, that the instrument used may not have been sensitive enough to the materials specific to the AAAS science program.

Westmeyer et al did find that teachers who had received formal instruction in the use of the AAAS program appeared to be more enthusiastic about teaching it than were those who had received their inservice education via the manual. In addition, the teachers in the inservice courses seemed to have received more desirable long-term benefits, as evidenced by their expressed opinions and observed classroom behavior.

Fischler and Anastasiow (29), operating on the assumption that 3:30 P.M. on a school day is not the best time for inservice activities, used the "school-within-a-school concept" of inservice education. During the summer session, teachers involved in the inservice program were paid to teach children in the mornings. Supervisory personnel were also hired to observe their classroom activities and to work with the participating teachers. "Clinical supervision" was provided in which the supervisors were responsible for helping the teachers maximize their strengths and minimize their weaknesses. In the afternoons, the teachers attended classes designed to provide them with additional background and with opportunities to work on various methods of teaching science.

Prior to the opening of summer school, the 35 teachers involved in the project attended four workshops designed to orient them to the Science Curriculum Improvement Study (SCIS) program and materials and to enable them to develop lessons centered around a science theme.

In the inservice program, the teachers were encouraged to use a discovery approach in which they asked fewer questions and encouraged their students to observe, question, discuss and formulate hypotheses about their science experiences.

Classroom sessions involving science were tape recorded in the spring before the inservice program was installed. In the fall, after the program was completed, 10 of the teachers involved in the program were visited and one science class was taped for each teacher, providing a before-after measure of teacher behavior.

Evaluation was accomplished through the use of teacher and pupil behavior and rating scales. The Flanders System of analyzing classroom verbal interaction was used with the tape recordings. A second analysis of the tape recordings was done to study the questions asked by the teacher. Questions were categorized as ones which asked students to (1) recall facts, (2) see relationships, (3) make observations, (4) hypothesize, or (5) test an hypothesis.

Only the data obtained on the 10 teachers participating in all phases of the study were analyzed for presentation of results. The investigators found a statistically significant number of these teachers allowed more continuous, uninterrupted student comment; asked fewer questions; and asked more indirect questions after having participated in the summer inservice program. Decreases were demonstrated for at least seven teachers in the percentage of question asking, direct questions, time teachers spent talking, allowance of fewer percentages of student comment which interrupted teacher lectures, and use of fewer relationship questions. Increases occurred for at least seven teachers in allowing more extended student comment and in asking more observational questions. Increases were also noted for at least eight teachers in the percentage of indirect questions they asked and in a higher ratio, in the fall, of indirect to direct questions. Nine teachers decreased the percentage of criticism they used.

The investigators assumed that they identified a relatively clear trend for the teachers to reduce their own participation in the class situation by asking fewer questions. In addition, most teachers asked more indirect questions (a term not defined in this report) and allowed students to answer at greater length. This teacher behavior resulted in a reduction of student answers of a factual nature and an increase in opinion and concept answers. On the basis of the limited sample of teachers involved, Fischler and Anastasiow concluded that their approach to inservice education had been successful and recommended that it be applied to other inservice areas as well as replicated in science with a new group of teachers.

Teacher Competencies

Breit (13) compared the effectiveness, in developing certain teaching competencies, of an inservice program and of a preservice program, both using Science: A Process Approach materials.

The competencies Breit felt necessary to deal effectively with new elementary science programs were (1) a positive perception of goals and methods of a curriculum program, (2) the facility for coping with a learning environment which emphasizes the child's responsibility for his own learning, and (3) a knowledge of course content. The specific competencies which he investigated were (1) a knowledge of the processes of science, (2) a positive attitude toward the goals and methods of a curriculum innovation, and (3) facility in coping with a learning environment which emphasizes the child's responsibility for his own learning.

Four groups were involved in the study: (1) the preservice experimental group, consisting of undergraduates enrolled in a science methods course, (2) the preservice control group, undergraduate students in a social studies methods course, (3) the inservice experimental group, elementary teachers enrolled in an elementary school science workshop, (4) the inservice control group, elementary teachers enrolled in the regular summer session. All four groups were pre-and post-tested, using the Science Process Measure for Teachers, the Instructional Decisions Test, and a semantic differential measure.

Breit was interested in determining the effect of the same treatment on two non-equivalent groups. Upon analyzing the data, he found that the inservice experimental group showed a significant change on 3 of the 36 measures involved in his study while the preservice experimental group showed a significant change on 5 of these 36. The concepts for which attitude changes were found differed for the two groups. Inservice participants showed a change in attitude toward the program itself, along with the methods of instruction utilized in the program. Preservice participants showed a positive change in attitude toward concepts related to the methods of the new curriculum. It appeared that the total experience had a greater impact on the inservice teachers.

The preservice participants had a significantly higher initial level of knowledge of the processes of science than did the inservice teachers. The level of knowledge of the undergraduate students, at the beginning of the program, was approximately the same as that reached by the inservice teachers at the end of the program. Both treatment groups made substantial change in their instructional decision behavior. The preservice people began at a significantly higher level than did the inservice teachers and retained this difference at the end of the program.

Breit concluded that preservice and inservice teachers who experience a similar teacher education program exhibit some similar changes and some contrasting changes. He also concluded that further study of these changes seems to support the idea that teacher education programs should be constructed to meet the differing needs of the participants.

Beringer (6) was interested in elementary teachers' competency to deal with scientific facts. She attempted to determine the areas of science in which elementary teachers needed more training so they could differentiate between statements based on heresay and statements containing scientific facts. She also wished to determine if the grade taught made a difference in the understanding of scientific fact.

She devised an instrument, "The Scientific Fact Test for Elementary Teachers," which she administered to teachers of kindergarten through sixth grade in four school districts. The 290 usable returns from the randomly stratified sample of teachers were anlayzed to determine the areas of science in which these teachers were best informed and least informed. Beringer also attempted to determine if the more recently graduated teachers were better informed than experienced teachers, if the grade level taught influenced the understanding of science, and if more training was needed in science in general or in specific areas.

She found that elementary teachers had a better understanding of the biological sciences than of the physical sciences, that teachers in the upper elementary grades had a better understanding of scientific fact than primary teachers, that teachers with more recent training possessed a better understanding of scientific fact than those who had been out of school for a number of years, and that elementary teachers needed more education in both the biological and physical sciences. Beringer found gaps in understanding of scientific fact in all areas. The teachers in her sample were best informed on the topic of birds and least informed concerning the earth. On the basis of this information, Beringer concluded there was a need for inservice courses in science at every elementary grade level. She advised that such courses be of a general nature rather than going into depth in any one science area.

Ashlock conducted a study using a method by which teachers could analyze selected competencies (5). The teachers involved in his study were enrolled in an off-campus methods course in science. As a part of this course, they engaged in microteaching activities in which they taught a five minute lesson involving a demonstration to a group of four peers.

Each lesson was evaluated and retaught. The points considered in the evaluation were (1) statement of lesson objective in terms of desired pupil behavior, (2) appropriateness of amount of material included in lesson in relation to available time, (3) clarity of purpose of demonstration, (4) pupil participation, (5) variation of stimulus situation, and (6) achievement of instructional closure.

Ashlock and his students found that if the teacher had not planned and stated the objective of the lesson in behavioral terms, it was difficult to achieve instructional closure within the allotted five minutes. Many of the teachers had problems in limiting the topic to this short period of time. Microteaching did prove effective, however, in providing the students with an opportunity to test ideas encountered in the methods course.

Curriculum Development and Inservice Education

The studies and reports described thus far have been primarily concerned with inservice education aimed at installing one of the newer elementary science curriculum projects. Two studies were identified in which the inservice education program was combined with curriculum development activities initiated at the local level (26,36).

A study by Crawford (26) was designed to develop a plan for the improvement of science education in the county elementary schools in Maryland. He collected information by interviewing administrative personnel, surveying teachers via a questionnaire designed to identify their needs for improving science teaching, and by making classroom observations as well as attending faculty meetings and science workshops.

Crawford concluded that the needs felt by the Maryland teachers can best be met by a comprehensive inservice program. He recommended five types of inservice activities: (1) workshops, (2) observation of teaching, (3) consultative service, (4) participation in professional organizations interested in the improvement of science education, and (5) extension classes emphasizing both content and methodology.

Jones *et al* (36) also stressed the use of inservice education to improve elementary school science education. Two school districts were involved in the study they conducted. Experimental and control groups were used, with the experimental group of teachers being given units developed by trained science consultants to provide the teachers with greater depth in subject matter. These teachers were also aided in clarifying science concepts which they expected to use and were helped to develop techniques for teaching science. Demonstration teaching and consultative service were provided at weekly seminar sessions focused on a particular grade level. The teachers in the control group received only a skeleton outline of the topics discussed by the experimental group.

Sixth grade pupils matched on the basis of intelligence and achievement were assigned to experimental and control groups. The children were pretested with the Sequential Test of Educational Progress (STEP) and the Acorn Achievement Test. They were post-tested with STEP Test, the Acorn Achievement Test, and the Bucknell Elementary Science Test.

Teachers were randomly assigned a group of children. At the end of the first semester the groups of students were rotated so that they were taught by teachers from both the experimental and control groups. The results obtained supported the use of consultants and demonstration teaching as methods for introducing science into the elementary school curriculum. The investigators concluded that inservice programs should include the development and use of science materials in conjunction with demonstration teaching if maximum effectiveness is to be obtained.

Teacher Attitudes, Behaviors, Characteristics

The largest portion of the studies reviewed for this section were concerned with the identification of teacher attitudes, behaviors, and other characteristics and the effect of inservice programs in bringing about changes in the participating teachers. Several investigators focused on verbal interaction [Hall (33), Coffey (24), Johnson (35)]. Others adopted a more global approach to the study of teacher behavior and use of teaching strategies [Ashley (4), Butts and Raun (19,20), White, Raun and Butts (55), Bohn, Butts and Raun (10)]. Two studies were concerned with teacher attitudes in relation to resistance to innovation [Uffelman (51), Rowe and Hurd (49)]. One investigator was interested in other teacher characteristics relative to participation in inservice programs [Brandou (11)].

Hall (33) attempted to determine if teacher behaviors are related to the curriculum they are teaching or to the training and supervision they receive. Three groups of second grade teachers (eight per group) were involved in his study. Group one participated in a five day summer workshop and received visits, on a biweekly basis throughout the school year, from a science consultant. Group two was involved in a series of inservice sessions during the school year prior to the official installation of the new curriculum. These eight teachers also received help from the K-12 science coordinators of their systems. Group three used a different course of study and received no inservice education relative to Science: A Process Approach materials used by groups one and two.

Hall developed the "Instrument for the Analysis of Science Teaching" (IAST) to gather the data he needed. The IAST instrument consists of two parts, one a 26 category system of interaction analysis, and the other a 15 item sign system completed at the end of each observation period.

Data obtained through the use of the IAST were analyzed to compare each of the two groups using the AAAS materials with the third group using a different science program. Hall found that teachers who participated in the summer workshop used fewer teacher open questions and fewer student open statements than did the group not teaching the AAAS program. There was, however, more student overt activity in the AAAS classes. When the group participating in the inservice program was compared with the group not using the AAAS materials, Hall found more student overt activity in the AAAS group but more student open statements in the non-AAAS program. In both comparisons, there were more teacher and direction statements observed in the classes using the AAAS materials than in the classes of teachers using "traditional" science materials.

Hall concluded that teachers teaching Science: A Process Approach do have some different teaching behaviors than teachers not teaching this course of study. He also concluded that a five day summer workshop and biweekly consultant visits were more effective for installing the AAAS program than was the inservice training during the school year combined with supervisory help.

Coffey (24) also focused on the verbal behavior of elementary school teachers who had participated in an inservice program. Teachers of grades one, two and three were involved in his study. Seventeen teachers constituted the experimental group and participated in the inservice program; the control group was composed of 19 teachers.

A pre- and post-test design was used. The 36 teachers were observed prior to the inservice program and tape recordings of four science lessons taught by each teacher were made. A classroom log was kept during each lesson. The tapes were analyzed using the Flanders system of interaction analysis. This procedure was repeated six months after the summer inservice program. In addition to these observations and analyses, the teachers were tested with the Facts About Science Test, the Sequential Tests of Educational Progress (STEP), the Test on Understanding Science (TOUS), and the Read General Science Test.

The teachers in the experimental group were involved in a four week summer science program using the school-within-a-school concept described earlier in the study by Fischler and Anastasiow (29). The teachers taught science core classes each morning, using AAAS materials, and were provided with clinical supervision during these times. In the afternoons the supervisors conducted feedback seminars for the teachers.

Coffey found significant differences between the pre- and post-test interaction analysis data on the teachers in the experimental group. Upon completion of the summer program, the teachers lectured less, increased teacher direction, allowed for less student talk, and provided for increased laboratory activity and silence in their classes.

Coffey concluded that inservice training programs aimed at changing teacher verbal behavior are feasible and can be accomplished by local educational agencies at modest cost. He also concluded that interaction analysis, as used in his study, is sufficiently sensitive to measure teacher change in classroom verbal behavior.

Johnson (35) is conducting a study designed to develop a model program for improving the questioning behavior of inservice elementary school teachers as they teach science. Microteaching is used in this study, with the lessons being videotaped. The rationale for this study stems from the fact that teachers tend to ask a preponderance of questions which stimulate only low levels of cognitive ability in their students. Since teachers ask questions which primarily call for the recall of facts or of information from past experience, they need help in developing the ability to ask questions designed to cause their pupils to process information and to make decisions.

Each teacher involved in Johnson's study teaches three 20 minute lessons. Each lesson is analyzed and retaught. Questions teachers ask are classified as (1) routine-management, (2) memory, (3) observation, (4) information processing, or (5) evaluative. Questioning profiles are established for each teacher.

Johnson is involved in analyzing and evaluating the data obtained from his study. Publication of the results should appear in the near future. At present the evidence obtained seems to suggest that the teachers participating in his study have made important gains in the quality and quantity of the productive thinking questions they ask.

Fischler also used videotaping in a study to determine if a four week inservice program could produce a change in teacher behavior (30). The teachers participating in this program worked with materials developed by the Science Curriculum Improvement Study (SCIS) in a school-within-a-school approach to inservice education: teaching classes in the morning and participating in inservice activities in the afternoon, during a summer session. Eleven teachers, of grades two through eight, were involved in this study.

Each morning one teacher was videotaped for approximately one hour while conducting science lessons. The tapes were analyzed by the group during the afternoon sessions. Three points were emphasized in this analysis: (1) the patterns observed in the teaching performance, (2) the effects of these patterns on the children, (3) the relationship of the observed teacher patterns and student behavior to the objectives of the individual lesson.

Additional observations were made of such topics as the levels of questions asked, number of times teachers called on boys in relation to girls, and the intuitive decision-making process of the teacher as he received a stimulus. No attempt was made, during this summer program, to develop a stereotyped pattern of teaching.

In the fall, elementary and middle school principals acted as observers so that the effectiveness of the summer program could be assessed. Fischler spent one week training the principals in the techniques of observation and gathering data as well as in the use of Bloom's Taxonomy in the identification of any strategies used in questioning.

The teachers also evaluated the program. They designed a questionnaire to be used to determine their attitudes toward the training. No data obtained with this instrument were included in the report by Fischler although he stated that the teachers' subjective evaluation of the experience was favorable.

The major complaint the teachers had of the project was that each of them appeared on videotape only two or three times. They would have preferred having more, but shorter, tapes to analyze. Fischler, as well as the participating teachers, appears most enthusiastic about the use of videotape as an objective tool for use in the analysis of the teaching-learning process. He considers videotapes more effective than written observations in identification of teaching patterns and their effects on students.

Ashley (4) examined the relationship between participation in an inservice training program and changes in teacher behavior. Data used in his study were obtained primarily from direct observation in classrooms, using a Classroom Observation Rating Form (CORF) which Ashley designed to identify teaching strategies emphasizing cognitive behavioral outcomes in pupils.

The Classroom Observation Rating Form contains four categories: (1) behaviors involving teacher-student interaction and student behavior, (2) teacher responses and actions, (3) teacher characteristics, and (4) physical aspects of the classroom environment. Strategies within each category are designated as Behavior A or B, with Behavior A strategies considered as desired or positive behaviors and B strategies as less desirable or negative in relation to producing student-centered learning environments.

Twenty-three teachers were involved in Ashley's study. They attended a series of inservice meetings designed to help them develop facility in using teaching strategies associated with Science: A Process Approach. Teachers were pre-and post-tested relative to attitude. Additional information was obtained about their teaching experience and grade level assignment.

The bulk of the data came from classroom observations. One observation was made prior to the start of the inservice program and involved a mathematics or language arts lesson. The first observation of a science lesson was made soon after the inservice program began.

Ashley found evidence of significant changes in teacher behavior relative to the use of specific teaching strategies between observations made of two sets of science lessons. These significant changes were in the direction toward greater use of B (less desirable) strategies. There were also significant changes between the first observation (made before the inservice program began) and the first science observation, as well as between the first and last observations. Both changes were to greater use of Behavior A strategies. The greatest change occurred between the first observation and the first observation of a science lesson, indicating that teachers reached a plateau of strategy use at the time of the first science observation and, from that point, the use of Behavior A strategies decreased. Nevertheless, the net result across the duration of the inservice program indicated an increased use of Behavior A strategies.

There were many significant changes in the mean attitude scores when pre-and post-test results were compared. All but 6 of the 36 factor score changes were in a positive or increased direction. Ashley inferred that these were due in large part to the inservice program.

When attitude change scores were correlated with the CORF change scores derived from the first and last science observations, six significant intercorrelations were found. All six were negative, indicating a negative relationship between these factors and change in teacher use of certain specific teaching strategies. There was a tendency to decrease in score on certain CORF variables accompanied by a tendency to increase in score on attitudinal variables. An increase in positive attitude did not result in increased use of positive teaching strategies.

Ashley did find a positive relationship between the grade level assignment and primary teachers' greater use of specific positive teaching strategies. The intermediate teachers involved in the study achieved less in the use of CORF positive strategies than could be predicted based on the total group performance.

The analyses of years of teaching experience and of use of specific teaching strategies did not provide significant evidence of a relationship between these two factors.

In discussing the conclusions involved in his study, Ashley questioned the value of using a teacher's attitude as an indicator of that teacher's actual classroom behavior. He does not think it wise to infer that a teacher exhibiting a positive attitude toward a curriculum sequence will teach this material more effectively than another exhibiting a less positive attitude.

Three reports, written by personnel from the Science Education Center of the University of Texas, are concerned with teacher change (19, 20, 55). In the first study in the series, Butts and Raun (20) attempted to determine the types of teachers in which a teacher education program could be expected to produce the greatest change in both the perception of the curriculum innovation and the practice of it. Four factors were selected as being important in contributing to this teacher perception of the curriculum innovation: (1) competence in science, (2) college science courses, (3) teacher experience with expecting and handling student responses, and (4) relevance of the teacher education program to the grade level taught.

The 19 teachers in this study were participants in an inservice education program designed to help them use Science: A Process Approach in their classrooms. These teachers were pre- and post-tested, using the Teacher Process Measure and a form of the semantic differential test. Observations, in which the Classroom Observation Rating Form was used, were made. The investigators also obtained information regarding science backgrounds, teaching experience, and grade level taught.

Butts and Raun found a significant correlation between a teacher's knowledge of science and perception of the impact of the scientist and of the curriculum innovation. The data they obtained suggested that the more college hours in science the teacher completed, the less she desired to teach science and the less positive was her image of a scientist. Teachers in the sample appeared less critical of an innovative science curriculum if they had fewer formal courses in science.

Another significant but negative correlation was that of the teacher's knowledge of science with her perception of the "activity" of teaching. This might suggest that the greater her knowledge of science, the less involvement the teacher sees of herself as a teller of information.

The investigators were unable to find any evidence that course hours in science, years of teaching experience, or grade level taught have a relationship to the strategies for classroom practices in teaching science. Those dimensions of the teacher's previous experience which were significantly related to a change in perception of a curriculum innovation included her competency in science, previous hours in science, and previous teaching experience. Butts and Raun inferred that a teacher education program could be expected to produce the greatest change in perception of the innovation with teachers having a number of years of teaching experience but few hours of college science.

They also inferred that competency in science appears to affect change in the teacher's practice of a curriculum innovation. If the teacher's competence in science is the major objective of an inservice program, the program should be successful since the development of this competence appears to be related to both change in teacher perception and to practice of the curriculum innovation.

The second report, also by Butts and Raun (19), was concerned with teacher attitude change. In this study, the focus was on those factors which contribute to the greatest attitudinal change in a teacher working with the AAAS program and materials. They investigated the effect of such factors as previous knowledge of science, relevance of previous teaching experience, relevance of teacher education program to grade level taught, and relevance of the program to school location.

Sixty elementary school teachers, employed in eight adjoining school districts, comprised the sample for this study. Their teaching experience ranged from 0 to 34 years (median: 7.5 years) and course work in science, 0 to 30 hours (median: 11.5 hours).

Teacher attitude was measured with a semantic differential instrument, both as a pretest and as a post-test. Butts and Raun found that teachers' attitudes do change when these individuals are involved in an inservice program aimed at increasing their competence in the processes of science. Teachers of grades one and two indicated a very positive change in how they valued teaching. The teachers of the intermediate grades showed little positive change or exhibited a negative attitude toward the value of teaching. The investigators inferred that the role of the teacher is more clearly defined or relevant at the primary than at the intermediate level of elementary school. They were unable to determine if the difference in effectiveness of the inservice program was a result of program instruction or of program materials.

Butts and Raun concluded that teachers with few or no formal courses in science exhibited more positive attitudes toward the impact of science, the impact of teaching, and the impact of the processes of science. Change in attitude did not appear to be related to years of teaching experience, nor was attitude change related to the school in which the teacher was located.

What factors contributed to the greatest positive attitudinal change? Grade level appeared to be a relevant contributor at the primary grades but not at the intermediate grades. Previous course hours in science were relevant for teachers with few or no previous hours of science. One question which the study did not answer is whether the degree of positiveness of the teacher's attitude governs the amount of modification an inservice program can make in the teacher's classroom practices.

White, Raun and Butts (55) described a study of contrasting patterns of inservice education. The teacher sample for this study consisted of three groups. Group A (33 teachers) participated in an inservice program, NSF-institute variety, emphasizing content in physics. Course content was selected from Science: A Process Approach and from college textbooks. Group B (33 teachers) participated in a week-long preschool workshop devoted to the inservice program for implementation of Science: A Process Approach. This session was followed by six one-day visits by the workshop consultant to the teachers in their classrooms. During these monthly visits, the consultant observed lessons, gave demonstrations, provided assistance, and conducted an hour-long seminar after school. Group C (74 teachers) met in 11 half-day sessions during the school year, in a released-time approach to inservice education. During these sessions they received instruction in the processes of science. The materials used were adapted from the AAAS teacher education program to meet area needs as these needs were identified by the Science Inservice Project personnel. All three groups were pre-and post-tested, using the Teacher Process Measure and a form of the semantic differential test.

White and her coworkers concluded that the format of the inservice program did appear to contribute to change in the teacher's competence in science and attitude toward the curriculum innovation. They inferred that a teacher derives more benefit from the inservice activities when she is aware of the appropriateness and approval of administrative personnel for her to use her newly-acquired knowledge in the classroom.

The investigators found no relationship of previous teaching experience and grade level assignment to a teacher's comptency in science. There were no significant differences between experienced and inexperienced teachers with respect to their preparedness for the philosophy of the new curriculum. The program also appeared to be equally relevant for all grades as far as teacher competence in science was concerned.

The amount of previous science training appeared to be a significant contributor to the effect of the inservice program, supporting the inference that an extensive knowledge base provides greater potential for change.

The greatest gain in competence in science was made by Group B, the preschool workshop group. This same group, however, showed significant regression in attitude toward inservice work, the curriculum program, the principal's view of the program, and the community's attitude toward it. Group C, the released time group, also exhibited an increase in competence in science but to a lesser extent than Group B. The teachers in Group C made the greatest attitudinal gain.

When the scores from the semantic differential test were analyzed to determine attitude change, those teachers with more teaching experience appeared to be the most perceptive to the impact of an inservice program and their active involvement in it. They were also more aware of the impact of the new course of study and much more concerned about how their principal viewed the program than were those teachers with less teaching experience. It was not possible, however, to identify specific reasons for grade level differences in teacher attitude.

Bohn, Butts and Raun (10) continued the study of teacher characteristics. The 110 elementary school teachers involved in this study were primarily volunteers in an inservice program preceding the use of Science: A Process Approach in their classrooms. The problem investigated was the identification of relationships existing between selected teacher characteristics and success in teaching a specific science curriculum (Science: A Process Approach). Factors investigated were grade taught, expectations of the school district personnel, teaching experience and academic preparation in science. Inservice records were analyzed to obtain biographical data.

Student achievement was used as the criterion of teaching success. Children were assessed through the use of the AAAS Competency Measure, an individually administered performance test consisting of a series of questions for each exercise. These questions are designed to measure behavioral achievement of the objectives of the exercise. Teachers involved in the study gave the Competency Measure to three children selected at random from their classes. A different group of students was selected after completion of each exercise to obtain a representative sample of each class. Each teacher taught a minimum of six lessons.

The Competency Measure scores were treated as the criteria to be predicted by (1) grade taught, (2) school district, (3) years of teaching experience, and (4) hours in science. Grade level was found to make a very significant contribution to the variation in competency measures.

Kindergarten teachers appeared to be more successful than other teachers. (The investigators hypothesized that this result may have been due to differences in the difficulty of the material at different grade levels.) The number of years a teacher has taught made a significant contribution to predicting teaching success. More experienced teachers had higher scores, in terms of student achievement, than did less experienced teachers. Bohn and her colleagues postulated that this result may have been caused by the ability of the experienced teachers to intuit their students' thought processes and thus become more able to judge what learning had taken place.

Rowe and Hurd (49) also studied teacher attitudes. They conducted an investigation into the use of inservice programs to diagnose sources of resistance to innovation. They wished to determine what factors should be considered in designing an efficient program for diffusing new styles of teaching elementary school science if they assumed that one means of translating a new curriculum into an action program was an inservice program. However, inservice programs that attempt to convey something of the style of teaching demanded by the new curricula in science present difficult problems for school personnel.

Rowe and Hurd provided one example of the employment of inservice programs to diagnose sources of resistance to innovation in teaching elementary school science. This study involved the use of a portable inservice education program in elementary school science introduced in the state of Colorado in 1960. A fully equipped laboratory housed in a trailer was sent to 11 sites in Colorado. At each site a consultant from the state's Department of Education conducted an inservice program in science and mathematics for elementary school teachers. Each site was visited twice in the year, for three days per visit. During the first visit teachers participated in three, three-hour lessons of the "learning by doing" variety emphasizing life science. The second set of lessons, given during the second visit, related to physical science topics chosen to develop and use measurement and number concepts. At the end of each session the teachers rated it on two three-part scales: Not Interesting, Interesting, Very Interesting; Not Useful, Useful, Very Useful.

Rowe and Hurd used the data from these scales to categorize the teachers as either potential resistors (those who marked the low and middle categories) and potential acceptors. They wished to determine to what extent interest and use were correlated and concluded that, of the two ratings, "usefulness" appeared to be the more sensitive indicator of possible sources of resistance to change. Apparently a high interest program is not sufficient for teachers to make any commitment to change. They must also perceive it as useful.

The investigators also found that teachers with 16-20 years of experience were probably a particular source of resistance. They were neither as interested as were other groups nor did they, in general, find the program as useful.

Any possible relationship between the academic background of teachers and their perception of the usefulness of a program was also investigated. Rowe and Hurd attempted to categorize the teachers as those with a great deal of science and mathematics and those with little background in science and mathematics. (They found over half of the group had never had any college mathematics.) Those teachers with up to 15 semester hours of mathematics found the program both interesting and useful. Those with 16 or more hours in mathematics found the program interesting but not particularly useful. There appeared to be no significant relation between the number of semester hours of science a teacher had and his rating of the program on either interest or use.

Although the teachers involved in the study verbalized the belief that children learn best by doing, they also felt their administrators wanted quite orderly classrooms. They felt a need to learn how to involve the children while controlling their enthusiasm.

Rowe and Hurd, after analyzing the data, made several inferences. (1) If it appears to the teacher that the model for teaching science in a new way is acceptable in principle but its implementation is perceived to risk the quality of the teaching act, then the teacher will resist making the change. If a new program appears to present potential management or discipline problems, teachers will tend to reject it. (2) Administrators, however, perceive the problems of teaching elementary science as stemming less from environmental and classroom management factors and more from lack of teacher know-how in science. (3) If teachers are correct in assessing the principal's norms for student behavior in the classroom, then there should be no difference in the importance each group attaches to management or discipline. Evidence obtained in the study tended to support these inferences.

Rowe and Hurd found that the science program was not equally effective at all grade levels. The primary teachers did not perceive the content as relevant to their pupils as did other groups. This may mean that special inservice sessions for primary teachers should be designed.

Rowe and Hurd concluded that resistance to change may be due to a number of factors which should be recognized by consultants attempting to install a new curriculum. The system itself tends to resist change. The resistance may result in part from the inservice program itself, and it may also be due to institutional variables. Therefore diagnosis, prescription and follow-up treatment must be developed that are appropriate to each district or school system. Data from this study suggest that teachers and principals not only focus on different difficulties that innovation presents, they often hold conflicting views. The consultant has the responsibility for examining these conflicts and, if possible, for finding a means to reduce them. The consultant needs to constantly monitor the inservice program to provide himself with a basis for designing corrective measures to maintain the system as it proceeds toward its goal.

Uffelman (51) was yet another investigator concerned with the problem of teacher attitude. His study was designed to determine whether the degree of personal involvement in a particular curriculum development project relates to its acceptance by teachers. Four degrees of personal involvement were used: (1) extensive participation in developing new science guides, (2) teaching in the school system during the development of the guides, (3) attending special inservice classes to prepare for using the guides, and (4) no connection with any of the activities listed in the other three categories.

The sample of 34 teachers was stratified according to the extent of their personal involvement in the science curriculum development program. Data were collected by means of personal interviews using an interview guide. Six measures were used in the study: (1) teacher acceptance of general objectives, (2) teacher acceptance of the teaching objectives, (3) teacher following of science units, (4) teacher use of suggested teaching techniques, (5) teacher use of recommended instructional materials, and (6) teacher knowledge of curriculum development procedures.

Uffelman found the degree of personal involvement in curriculum development did relate to its acceptance by teachers, to their use of the recommended science units and materials, and to their knowledge of curriculum development procedures. It was possible, however, that the associations found in this study could have resulted from the method of selecting teachers for the planning and inservice group and not from their participation in the activities.

Brandou (11) investigated certain factors related to physical science inservice programs for elementary school teachers. These inservice programs were conducted by secondary school science teachers trained for their responsibilities through participation in an Elementary Science Inservice Conference (ESISC) sponsored by Michigan State University and the National Science Foundation. During the four week summer session, these teachers, under the direction of subject matter specialists and educational consultants, prepared eight "Topic Guides" for use in the inservice activities.

Brandou obtained data from conference participants, a sample of the elementary school teachers in each system involved in the project, and from school administrators. The secondary school science teachers were extensively tested, using six different instruments. The elementary school teachers were asked to complete the ESISC Elementary Teacher Questionnaire.

Brandou wished to identify and investigate factors affecting the outcomes of this experimental inservice program in which the secondary school science teachers were responsible for conducting the science inservice activities for their elementary school colleagues. He found that experienced secondary school science teachers were more effective inservice instructors than those with less experience and that teachers who had been in a system for a relatively long period of time were more effective than those who had recently joined a particular staff. Knowledge of the specific system and an established position within it may be contributing factors.

Brandou also found that elementary teachers with more teaching experience were more likely to participate in the inservice program than were less experienced teachers. He was unable to determine if this might be interpreted as evidence that the program offered more to the experienced teachers or that they were more interested in science education.

He concluded that the program was well received by teachers at all grade levels but that it appeared to contribute more to teachers of grades three through six than to teachers of kindergarten through grade two. Neither the evaluation of the program nor the reported changes in teaching practice appeared to be related to number of years of teaching experience. The administrators rated the program more highly than did either the elementary or the secondary school teachers.

Brandou also found that the inservice program in science was only one of a variety of inservice activities from which the elementary school teachers in the 16 school districts had to choose. This fact emphasizes the need for an inservice program which can meet competition if participation in it is a voluntary activity. Those science inservice programs that afforded teachers with opportunities to come in contact with science teaching materials useful at their own grade level were most frequently highly rated. The most important contribution listed by the elementary teachers participating in the study was gain of information about science and science teaching and the stimulation of interest in the physical sciences. The most serious shortcoming reported was the difficulty of scheduling meetings of adequate length with sufficient frequency in view of the other demands on teachers' time.

SUMMARY

More than 40 studies and reports were reviewed for this paper. This material can be classified as program descriptions and reports, materials with a primary focus on evaluation of inservice activities, and research studies and reports relating to inservice education in science for elementary school teachers.

Inservice education may be considered to have four broad goals: (1) skill training, (2) acquisition of information, (3) attitude change, and (4) general self-improvement (3). These goals of attitude change and of acquisition of information appear to have received the most attention in elementary science inservice programs.

The task of attempting to analyze these goals in terms of inservice activities has proved a difficult one. It is easy to determine if a teacher has acquired information by administering an achievement test or battery of tests. Determining attitude change is a more complex task as evidenced by some of the studies cited (4, 13, 50). It is difficult to provide evidence that the attitudes teachers profess to possess are those which also govern their classroom behavior. An additional complicating factor is that attitude change is a slow process and most of the inservice evaluative and research studies have not been long-term.

General self-improvement is a goal that appears to lend itself to subjective evaluation. Many of the investigators reported that the teachers considered that their teaching, interest in science, and attitude toward teaching science had increased as a result of their participation in inservice programs. Therefore, self-improvement may be considered as a fringe benefit in a program pointed toward a different goal.

The dearth of reports of inservice programs aimed at developing skills is amazing. In some of the studies involving some of the newer elementary school science courses of study, the teachers did learn to use the materials and apparatus but this was not the primary purpose of the programs reported. Writers continue to decry the inadequate science content backgrounds of elementary school teachers. Investigators determine that many elementary school teachers are reluctant to teach science because they feel inadequately trained. However, few inservice programs make the development of laboratory skills part of their attempt to increase competency in science. No inservice programs were reported in which there was any attempt to provide elementary school teachers with an opportunity to participate in scientific research.

In addition to the usual laboratory skills involved in science teaching, elementary school teachers need to acquire skill in evaluating and using much of the educational hardware that is available today. No studies emphasizing this aspect of teaching were located.

The effective use of interpersonal communications may also be considered as a teaching skill. If materials reviewed are analyzed for this skill, a few studies were identified (24, 29, 35). These tended to be primarily of the research type in which the inservice activity might be considered to be of as much benefit to the principal investigator as to the teachers involved. The emphasis in these studies appeared to be that of the verbal interaction of the classroom, especially of the types of questions teachers asked. Nonverbal behavior was not investigated. If one judges by the reports of increased amounts of teacher direction statements in some studies (4, 24, 33), the programs did not result in changing teachers to encourage their students to become independent investigators.

Apparently some teachers perceive inservice programs aimed at helping them use new science curricula in their classrooms as threats to their security and established routines (49, 51). Only a few investigators were concerned with this problem. For the majority of persons concerned with inservice education, the assumption appears to be that the benefits of new programs and/or inservice activities are so obvious that these benefits will outweigh all objections to the installation of the programs.

In addition to failure to consider possible opposition or resistance to change, many of the programs reviewed appeared to lack a research base for the plan of action followed. Needs for inservice education were identified and steps were taken to meet these needs. Lack of sufficient research prior to development and implementation of inservice activities may result in programs that are inappropriate. These programs may treat the symptoms of the need but never identify and deal with the cause of the need.

Systems lacking the personnel and expertise to develop good inservice programs might develop a working relationship with some college or university or might establish contacts with one of the Regional Laboratories or with a Research and Development Center. The benefits deriving from such an arrangement may be illustrated by the reports from the Science Inservice Project cited earlier (10, 19, 20, 55). This project, staffed by personnel associated with the Science Education Center at the University of Texas in Austin, has four primary objectives: (1) to provide information about curriculum innovation through both awareness conferences and demonstration classes, (2) to demonstrate curriculum innovations in local districts through pilot studies which include both a model inservice teacher education program and an opportunity to assess district support for change, (3) to conduct leadership training and coordinate follow-up activities for staff of districts or service centers, and (4) to develop alternative approaches to leadership development and teacher education (17).

The curriculum innovation emphasized in the Texas Science Inservice Project is Science: A Process Approach. Operating on the assumption that the effectiveness of any curriculum innovation is directly dependent upon the preparation of the teacher, the personnel involved in the project have designed an inservice program to meet two needs: (1) that of increased teacher competence in the subject area, caused by inadequate academic background and (2) that of a program to increase teacher competence in teaching strategies for inquiry, resulting from inadequate teacher strategies to foster inquiry and individual responsibility in learning. The key means by which specific needs have been identified has been the use of teachers as a source of information concerning both the problems and their relevant solutions.

One focus in this Inservice Project has been that of manpower development. Project personnel are concerned with helping the individual classroom teacher and with developing a local leadership staff within a school system as well as a regional staff or staff of a local college. All of these individuals have as their ultimate concern the provision of effective learning experiences for students.

The inservice program used by the Science Inservice Project has been written by teachers and revised as they have experienced needs in the classroom use of materials. As the teachers work with students, they begin to identify strategies which prove successful in guiding the learning experiences of their students. As they analyze the classroom experiences, the teachers see a need for new knowledge about teaching as well as a need for guidance in the development of understanding of the new course of study.

Project personnel have based their approach to inservice education on three assumptions: (1) knowledge of the innovation precedes and is essential to its implementation, (2) commitment to use the innovative curriculum is essential to its implementation, and (3) guidance in the use of the innovation is essential to its implementation. The primary focus in this program is termed "the educational encounter" in which both students and teacher work with the new materials.

The Far West Laboratory for Educational Research and Development (28) is also involved in inservice education. Personnel of the Laboratory are attempting to develop a series of inservice education packages, based on findings from the Stanford Research and Development Center.

Local programs presently available for public information constitute only a small portion of the references cited in this paper. Many of the reports resulted from joint efforts of several school districts. If one accepts the assumption that more inservice activities are initiated at the local level than the few which appear in print, one might also share the concern that information regarding these programs, their successes and failures is not more readily available.

When materials were reviewed for this and another occasional paper, on inservice education for secondary school science teachers, a proliferation of studies and reports about National Science Foundation institute programs for secondary school science and/or mathematics teachers was found. This did not hold true for programs for elementary school teachers. Only one report (56) could be categorized as being based on an institute program. Although the number of institute programs available to elementary school teachers is small compared to those for secondary school teachers, the National Science Foundation is providing grants to help school systems improve their elementary science and mathematics curricula. Inservice education is one of the foci of many of the Cooperative-College School Science Programs funded by NSF. A representative sampling of these CCSS programs was located in an issue of Science and Children (21). Nineteen institutions located in 17 states and the District of Columbia were identified and a brief description of the program of each was provided.

It seems inevitable that school and college personnel will continue to be involved in inservice education. One writer has listed eight problems as factors contributing to the need for inservice education (48). These problems are (1) rapid obsolescence of subject matter knowledge and skills, (2) the proliferation of educational hardware, (3) the fluid but apparently evolving state of learning and instructional theory, (4) the advent of new educational tasks, (5) a growing necessity for global awareness, (6) the acceleration of school reorganization, (7) the consequence of teacher misassignment, and (8) the problem of teacher drop-outs. All eight of these seem as applicable to elementary school as to secondary school.

Another facet of the problem has been high-lighted by Goodlad, in "The Schools vs. Education," (32) when he wrote

> Public schooling is the only large-scale enterprise in this country that does not provide for systematic up-dating of the skills and abilities of its employees and for payment of the costs involved. Teachers are on their own as far as their inservice education is concerned...

If this is a valid criticism of the situation, and it appears to be in many school systems, much work needs to be done to improve inservice education in science, as well as in other content areas, for elementary school teachers.

The picture is not an altogether bleak one. Two investigators (24, 29) reported on the school-within-a-school concept of inservice education, furnishing evidence that some systems are concerned about providing their teachers with a means of improving competency. These activities took place during the summer session of school. Can this school-within-a-school concept work equally effectively during the academic year?

It is difficult to consider inservice education apart from the broader framework of innovation and change. Historically, inservice education was developed to correct deficiencies of preservice education. Providing a preservice program that will enable a prospective elementary school teacher to develop any reasonable amount of competence in science is an almost insurmountable problem. Concerned groups have been attempting to develop solutions and to provide guidelines for the structuring of preservice programs. The most recent publication is a preliminary report on "Preservice Science Education for Elementary School Teachers" (1). This document resulted from three conferences, convened to develop standards and guidelines, sponsored by the American Association for the Advancement of Science Commission on Science Education and the National Science Foundation.

The problem confronting the conference participants is highlighted in the foreword of the report:

> Elementary school teachers constitute the largest professional group in the United States. Each year 85,000 elementary teachers are graduated from more than 1,200 institutions of higher education. These teachers are expected to teach language arts, social studies, mathematics, health, fine arts, and physical education in addition to science. Their task is complicated by the fact that recent curriculum projects in mathematics, science, and other areas

> have redefined what should be taught in elementary schools. While science in elementary schools has been completely changed, most science courses for teachers at the college level have changed little or not at all. . .

Even if this gap (between college science courses and science in elementary school classrooms) did not exist, is it possible to achieve breadth and depth in science as a part of the undergraduate education of a prospective elementary teacher? It would appear that the need for inservice programs in science is one that will never disappear.

When such inservice programs are being designed, should provision be made for different programs for experienced vs. beginning teachers, for primary grade teachers vs. teachers of the upper elementary grades, for teachers with little college science vs. teachers with 15 or more hours of college credit in the sciences? Studies by Breit (13), Ashley (4), Butts and Raun (19), Rowe and Hurd (49), and Brandou (11) touched on these problems.

The studies and reports reviewed were so varied that it is not possible to make any all-encompassing generalizations about them. If one major statement is to be made relative to the materials reviewed for this paper, it is that they have served to identify numerous problems that deserve more attention by persons concerned with inservice education in science for elementary school teachers.

RECOMMENDATIONS

General Recommendations

Three general recommendations may be made concerning reports and studies of inservice education activities in elementary school science. (1) A greater variety of research methods should be attempted in inservice education than have been evidenced by the materials reviewed. (2) Studies should be reported in sufficient detail that they may be replicated. (3) More of the local programs and activities concerned with elementary school science inservice education should be written up and made available for public information. A rationale for these statements is to be found in the following paragraphs.

The majority of studies cited in this paper, if involving research at all, have been of the type of research categorized as descriptive. Some were status investigations; some involved questionnaire surveys. A type of research study, commonly known as "action-research", was not much in evidence in the documents reviewed. This term possesses a variety of definitions and is used here to refer to research studies which take place within the context of the regular school program and are carried out by the school personnel normally involved in the program. Such studies may entail a change in teaching methodology, instructional theory, content, or a local approach to inservice education, to provide a few examples. These studies have been subject to criticism by educational researchers because many studies did not, in the opinion of the researchers, meet all of their personal or institutional criteria for research. Nevertheless, if school personnel can secure help in designing and initiating action-research studies, these would be of benefit to the systems involved.

There were a limited number of experimental research studies in which different treatments were applied to different groups. Pre- and post-treatment tests were administered to these groups and data were used to determine the differential effects of the treatments. Such studies are infrequent occurrences in inservice education. Although the question of the comparableness of different groups can always be raised, programs should be tested before being installed on a system-wide basis. Perhaps some educators feel that if a treatment (program, activity, new course of study, curriculum innovation) is going to benefit the individuals involved, it should not be denied the total population merely for purposes of comparison. The assumption that the implementation of an untested program will prove beneficial is open to question.

Frequently when different treatments were used, the investigators did not supply sufficient detail to ensure accurate replication. Doctoral dissertations provide brief descriptions of methods used to analyze data obtained but these, too, are frequently reported too briefly to provide adequate guidance for other investigators wishing to replicate the study.

Much of the literature reviewed for this paper cannot be strictly classified as "research". Doctoral dissertations were in evidence but many other documents were reports rather than research studies. There is need for more investigations of inservice education that merit the title of "research". In some instances the problem investigated was a relatively minor one. In other studies, a simple design was used to study a complex problem. Frequently variables that appeared to be relevant to the major problem of the study were not considered or received little consideration.

Of the few reports and studies concerned with local inservice programs and activities, many were obtained through personal contact or the investigation of a brief reference in a more general paper. Local school systems tend to limit the dissemination of information about their activities to the population they serve. Reports sent to a center such as the ERIC Clearinghouse for Science Education can be circulated more widely. These reports can be processed and their existence made known through newsletters and bibliographies distributed from the Clearinghouse.

Specific Recommendations

The more specific suggestions or recommendations which follow are concerned with the topics of (1) the development of local inservice programs, (2) teacher attitudes, behavior, characteristics, and (3) the adoption, acceptance, and implementation of curriculum projects. The statements are descriptive rather than prescriptive. Questions are raised for consideration rather than as demands for immediate action.

Suggestions and Recommendations Regarding Local Inservice Programs

(1) Inservice activities should be locally initiated and developed (on a system-wide basis).

One of the major criticisms of inservice work is that many of the programs have been planned by sources removed from the local situation. New curriculum materials have to be implemented by people who did not originate them. If these materials are to be used properly, the teachers need to know (1) what to do in terms of both content and the instructional strategies, (2) how to do it, how to implement the strategies involved, and (3) why to do it that way (18).

This does not imply that programs and materials developed by the national course content improvement projects or by publishing companies are not of value. Individuals participating in the development of new curricula contribute expertise and perspectives far beyond those a single school system or district is able to command. Nevertheless, this broad approach must be redefined and focused on problems existing at the local level if any real and lasting improvement is to occur.

This means that individuals responsible for structuring and initiating inservice education activities must have a broad background in inservice education *per se* as well as in the content area(s) involved. Several sources of information are available to those wishing to attain this perspective. One is a document entitled "Inservice Education - - Psychological Perspectives" (3). Written by James F. Asher for the Far West Laboratory, it is a report summarizing and evaluating literature and research relevant to inservice education and concerns the psychological settings for behavioral change.

Asher's report is divided into seven parts: (1) history of inservice education, (2) ideal goals of inservice training, (3) analysis of inservice programs that have been tried, (4) 'the acceptance of innovation', dealing with the question of resistance to new ideas, (5) evaluation of inservice programs, (6) future inservice programs, and (7) recommendations.

An even more extensive survey of literature was also prepared for the Far West Laboratory by Dorothy Westby-Gibson for her report, "Inservice Education--Perspectives for Educators" (53). She included a 184 item bibliography which covers newspaper articles, journals, books, and other materials published from 1950-1967. The topics in this report cover new practices and devices such as (1) systems analysis, (2) interaction analysis, (3) microteaching, (4) sensitivity training, (5) various electronic media, and (6) the diversification of staff and duties.

A third source of information is the Guba-Clark Classification

Schema of Processes Related to and Necessary for Change in Education (23). In this model the developers explain the phases they consider to be involved in initiating change in education. These phases may be categorized as research, development, diffusion, and adoption.

These sources, plus selected chapters in Innovation in Education, edited by Matthew B. Miles (41), can serve to provide a background for considering inservice education activities. In Chapter 10, the strategies used in developing and disseminating the Physical Science Study Committee's high school physics course are discussed. Although the task facing the PSSC personnel was one of nationwide implications, many of the methods they used can be adapted to local programs and activities at the elementary school level as well as in secondary school science programs.

(2) Research needs to be done to determine what strategies work best for introducing and using new ideas in the classroom.

The problems involved may vary with the school system. Three models for inservice education approaches have been suggested in a monograph from the Research and Development Center for Education at the University of Texas. These models are the laboratory approach, the classroom experience model, and the teaching demonstration model. All three are described in detail as they have been used in inservice activities in "Designs for Inservice Education", E. W. Bessent, editor (7). These models, reportedly used in the Austin area, should be investigated and compared to determine which meets with the most success and in which situations each can be used most successfully. More importantly, perhaps, other models can be developed and tested.

(3) Inservice programs should attempt to articulate the science within a total school system, K-12.

More attention should be given to programs and activities that begin with kindergarten and are developed upward rather than continuing the current approach of modifying the elementary science program to fit the dictates of the secondary science courses.

The following questions are suggested as points for consideration: Is there a consistent approach and philosophy throughout the student's educational experience in science? Does he function in the inquiry mode in elementary school only to be confronted by textbook-oriented science in the secondary school or science courses dominated by the objective of college preparation? Or does his elementary science experience consist primarily of reading about science rather than doing science so that he is ill-prepared for any secondary school science course in which he is expected to demonstrate that he already possesses a command of the processes of science and can use them as an independent investigator?

(4) Research needs to be done to determine strategies which may be used to develop personnel within the school system who are qualified to guide the development of an inservice program.

Outside consultants, on a short term basis or in some continuing liaison with the school system, may be obtained for the initial stages of development. Such individuals eventually return to their own establishments and the personnel of the local system have the task of continuing the development of the program. What methods can be used to develop leadership at the local level so that the activities may be maintained and modified, if need be, to meet future needs for inservice education? Can strategies be devised to enable individuals assuming this leadership to also continue to function effectively in the classroom?

(5) Research to identify the most effective time for inservice activities needs to be continued and expanded.

Finding time for inservice activities apparently has always been a problem. Teachers are not at the peak of enthusiasm at 4 P.M. on a school day. An inservice program, in order to achieve maximum effectiveness, should be built into the school day. Provision must be made for released time for teachers involved in development and inservice activities. The school-within-a-school approach described earlier in this paper is one method. Alternatives should be developed and tested. Another solution would be to pay teachers for inservice participation, either with additional cash or credits toward the next salary increment. Either plan requires money, for the substitute who takes charge of the class or for the teacher involved in the inservice program.

Work needs to be done to identify what plan works best for a particular school, both in terms of teacher acceptance and in terms of actual change evidenced in the classroom. Still other approaches to the time problem need to be devised and studied.

(6) More attention should be given to the possibilities inherent in the development of regional centers to serve as loci for inservice activities and the development of curricula and materials.

Many smaller school systems are unable to muster adequate finances and personnel to carry out inservice education. If several systems were to pool resources and funds, all involved would benefit. Some examples of joint efforts already exist, e.g. the Pacific Science Center in Seattle and the Bi-State Project (8, 46). Such regional centers could be assisted, at least in the initial stages, by personnel from various Regional Laboratories and by members of science education faculties from a local college or university, as illustrated by the Texas Science Inservice Project (17). Such a consortium of school districts should be more effective in attacking their common problems than each working independently would be.

More systems should become involved in Cooperative-College School Science Projects such as that of Flint Hills (14). Such ventures bring with them both funding, through the National Science Foundation, and consultant services from college personnel. An additional benefit that frequently appears is the development of commitment, within the district, to continuing the program when the federal funding ends.

In summary, if inservice education is to be successful and productive at the local level, as well as at county, state, or national levels, the factors of time, finances, personnel and appropriateness must be considered. A common conclusion about effective inservice programs appears to be that they (a) involve released time, (b) require special instructional materials (in many cases), (c) make appropriate use of outside consultants, and (d) demand adequate commitment of supervisory and administrative time to the program. In addition, the program designed must be such that it will be perceived as being useful by the teachers who are to be involved.

Suggestions and Recommendations Regarding Teacher Attitudes, Behaviors, Characteristics and Inservice Education

(1) More research needs to be done in the areas of teacher attitudes, behaviors, and characteristics as these are related to inservice education.

Some of the studies of inservice programs contained information on teacher attitudes and characteristics. These were primarily doctoral dissertations. Such investigations frequently have little impact on the population involved in the study, serving primarily as a vehicle for obtaining a degree. More research of the type that is beneficial to both the investigator and those with whom he works needs to be done.

Schools, and teachers, have been said to be resistant to change because their primary function is considered to be that of transmitting "the culture." If this is a valid statement, can the source(s) of this resistance be identified? Does what constitutes the culture in elementary school science teaching change over time? If it does, how can we prepare teachers to recognize and act upon this fact?

If it is true that resistance to change and to new ideas and courses of study exists among school personnel, research needs to be done to determine the degree to which this resistance exists. What methods can be devised to identify reluctance to change? What factors account for it, if resistance does exist? How can new ideas and methods be introduced without having the teachers feel threatened? What can be done so that teachers and their administrators are better able to communicate accurately their concerns and goals relative to the newer approaches to elementary science education?

Does the degree of acceptance of a new program or other innovation involving inservice work vary with the number of individuals initially involved in design and implementation? More studies need to be done in an attempt to answer this question.

Is the verbalized philosophy of classroom teachers consistent with the teaching strategies employed in their classrooms? Studies (4, 50) can be cited that would cause one to doubt the automatic transfer of professed attitude into classroom behavior. If we accept the assumption that "teachers teach as they are taught," should teachers about to adopt new curriculum materials which involve new teaching methodology experience the course in the same way that their students will experience it? Will such a treatment guarantee that the changes will be in evidence in the classroom? How can we find out?

(2) Follow-up studies need to be done to determine what changes in teaching are really made by individuals who have been exposed to inservice activities as well as the continuing effect of such experiences on teaching patterns.

Can inservice programs be designed that enable a teacher to become a flexible, innovative person in the classroom? Should experienced and beginning teachers receive the same type of inservice program to prepare them for a new curriculum? If the programs and approaches should differ, in what ways should they vary? Should programs and approaches be modified for different grade levels as well as for amount of teaching experience? When does an inservice program produce the most impact in the form of changed teacher behavior: soon after the completion of the inservice work or after the teachers have had time to work with the curriculum innovations in their classrooms and to become comfortable with the new materials? Does the change in teaching, if any, tend to diminish if not periodically reinforced by some type of continuing inservice work? If so, what types of activities can be used to maintain the desired changes?

(3) Research also needs to be done to determine what types of inservice programs are most effective in helping teachers attack the problem of attitude change.

What types of activities work best where elementary school teachers and science are concerned? Do experiences which help elementary school teachers objectively examine themselves, their attitudes toward science, and teaching methodology differ from those which achieve success with these same teachers in other content areas? How much time should be involved in an inservice program emphasizing attitude change? Should such a program be a concentrated one, such as a six-week summer program, or, since attitude change is a long-term process, should the activities be spaced throughout the school year?

Studies have revealed a lack of change in attitude toward teaching by participants of inservice programs. What can be done to change the basic attitude regarding instructional methods that many of the experienced teachers involved in the studies appeared to hold? A specific research problem that may be pursued in relation to recommendation 3 is that of attempting to determine the role that the act of teaching the science materials may have played in this lack of attitudinal change.

(4) Research to determine the type(s) of mental processes teachers do and do not need to perform the behaviors required for the processes of science is needed.

In inservice education for elementary school teachers who are about to use the new courses of study, emphasis has been placed on helping these teachers work effectively with these materials. Many of the newer elementary school science projects emphasize the processes of science rather than the products. Many of the classroom teachers confronted by these new materials with their concomitant new approaches to learning need to have experiences in which they are able to comprehend the ideas involved as well as to gain familiarity with materials.

What types of inservice activities can be devised that will result in greater teacher perception of learner needs or in strategies of teaching which enhance learner needs? Will the use of videotaping techniques help teachers to become more objective self-evaluators of their competence to create desirable learning environments?

Suggestions and Recommendations Regarding Adaptation, Acceptance and Implementation of Curriculum Projects and Materials

(1) Investigators need to design measures for determining the understanding by the classroom teachers of the philosophy and rationale of the program they are adopting.

It is generally assumed that the new elementary science projects are predicated on a philosophy different from that of the "traditional" elementary school science programs which emphasized reading about science. Will learning to manipulate the equipment and materials involved in the newer science programs provide the elementary classroom teacher with all the skills needed for the program to be effective? Is it not necessary that teachers also understand, and accept, the philosophy accompanying the new course? Can the teacher demonstrate this understanding in teaching behavior? The statement has already been made that what a teacher says he believes and what he practices in the classroom are not necessarily identical. Can reasons for the existence of this incongruity be identified? Do the reasons lie within the teacher or within the situation in which he operates? What can be done, via an inservice program, to change the situation if this needs to be done?

(2) More research and development activities relating to the inservice education component of the new science programs need to be carried out.

When the elementary school science projects were first proposed for funding, their primary objectives were the design of a new course of study and the development of appropriate materials and activities. Now it is time for an equivalent effort devoted to the inservice component of these new programs. More evaluative research needs to be done to determine the effectiveness of the various approaches to inservice education that are associated with the different elementary science projects. Is there a general approach that appears to work equally well with any and all programs or does each project require a unique approach?

(3) The need for inservice programs designed for teachers who are teaching science to different cultural groups should be investigated.

This area appears to have received only a fraction of the attention it deserves. Should science teaching for bicultural groups be different from either that which we have been traditionally teaching or the newer curriculum projects? Is science for the inner city elementary child necessarily different in content and approach than science for the child living in the suburbs or in a rural area? If so, what needs to be done to prepare experienced, as well as beginning, teachers to function effectively in their assignments? What new methodologies need to be developed and used? How can this best be accomplished?

(4) Inservice programs to prepare teachers for the multi-media approach to science education need to be designed.

New materials and teaching tools continue to be developed and marketed. Teachers need to be provided with opportunities to become competent in evaluating and using the many pieces of educational hardware now on the market. What are the most effective ways of helping teachers use television, videotaping, programed instruction, etc. in their classrooms? Are these most effective ways also the most efficient? If not, can effectiveness and efficiency be combined satisfactorily?

Elementary school teachers have been involved to a larger extent, perhaps, than have secondary school teachers in such ventures as team-teaching, the use of auxiliary personnel, and other changes that result from the concepts of differentiated staffing, the ungraded primary, etc. What types of science inservice programs can be designed and tested for effectiveness in helping teachers successfully encounter and utilize these ideas along with the educational hardware?

(5) Research needs to be done to determine ways of providing continuity for a program in which the personnel involved in its implementation are changing.

If the average tenure of an individual in teaching is three to five years, should programs be designed that run in three year cycles? How can inservice programs be designed to promote continuity while also promoting the idea that innovation and change are necessary and desirable in education? Can a well-designed inservice program aid in decreasing the rate of teacher "drop-outs" within a system?

A possible approach to this problem might be based on the procedure used by the Commission on Science Education of the American Association for the Advancement of Science in the summer writing programs for Science: A Process Approach. Confronted with the need for maintaining continuity in the writing despite the changing personnel in summer writing groups, the Commission decided that objective evidence of student accomplishment could be used to provide the necessary continuity. This objective evidence was derived from an analysis of competency measure scores. A more detailed account of this procedure as well as an elaboration of the evaluation model involved are to be found in "An Evaluation Model and Its Applications" (2).

Similar approaches might be applied to the development of inservice programs and activities and might serve to compensate, in part, for the difficulty of maintaining continuity in spite of changes in personnel.

In Conclusion

The fifteen specific recommendations put forth in this section of the paper by no means exhaust all of the possibilities of research related to inservice education in science for elementary school teachers. In addition, the present state of research is not definitive enough to provide a basis for mandating inservice education practices. It is hoped, however, that this paper will serve as a contribution to the profession through the identification of some sources of information, the citation of many recent studies, and the summarization of some problems involved in developing elementary school science inservice programs.

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